CEMENT AND LIME MANUFACTURE

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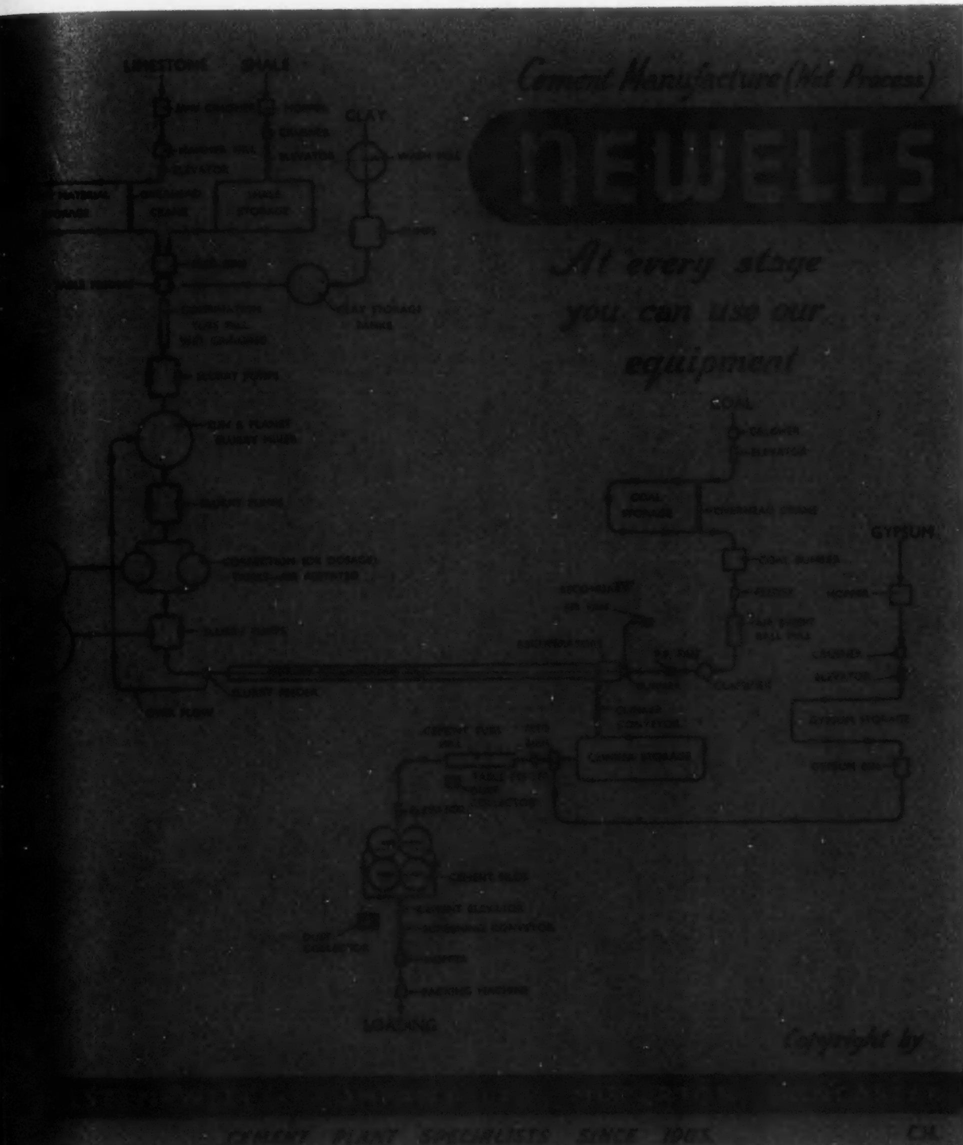

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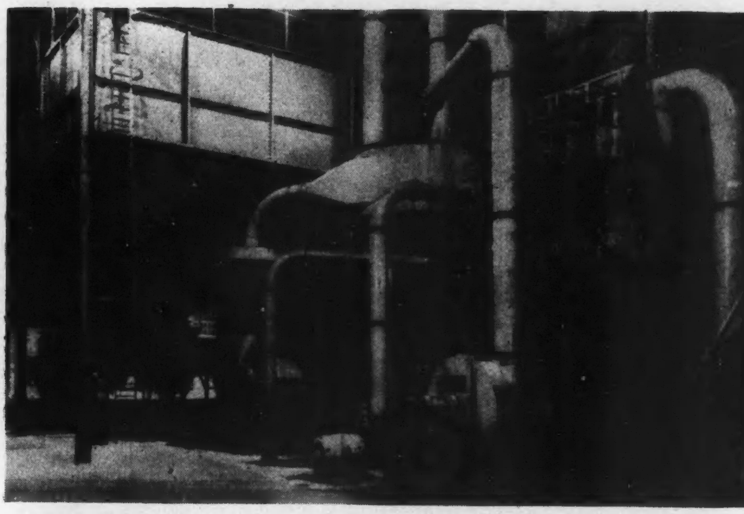

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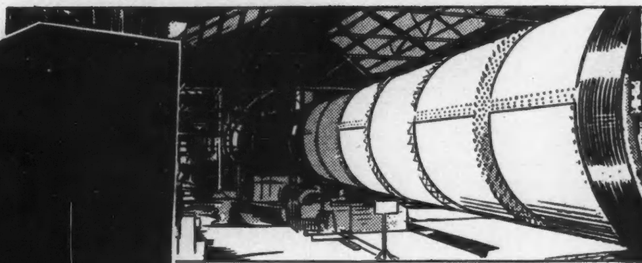

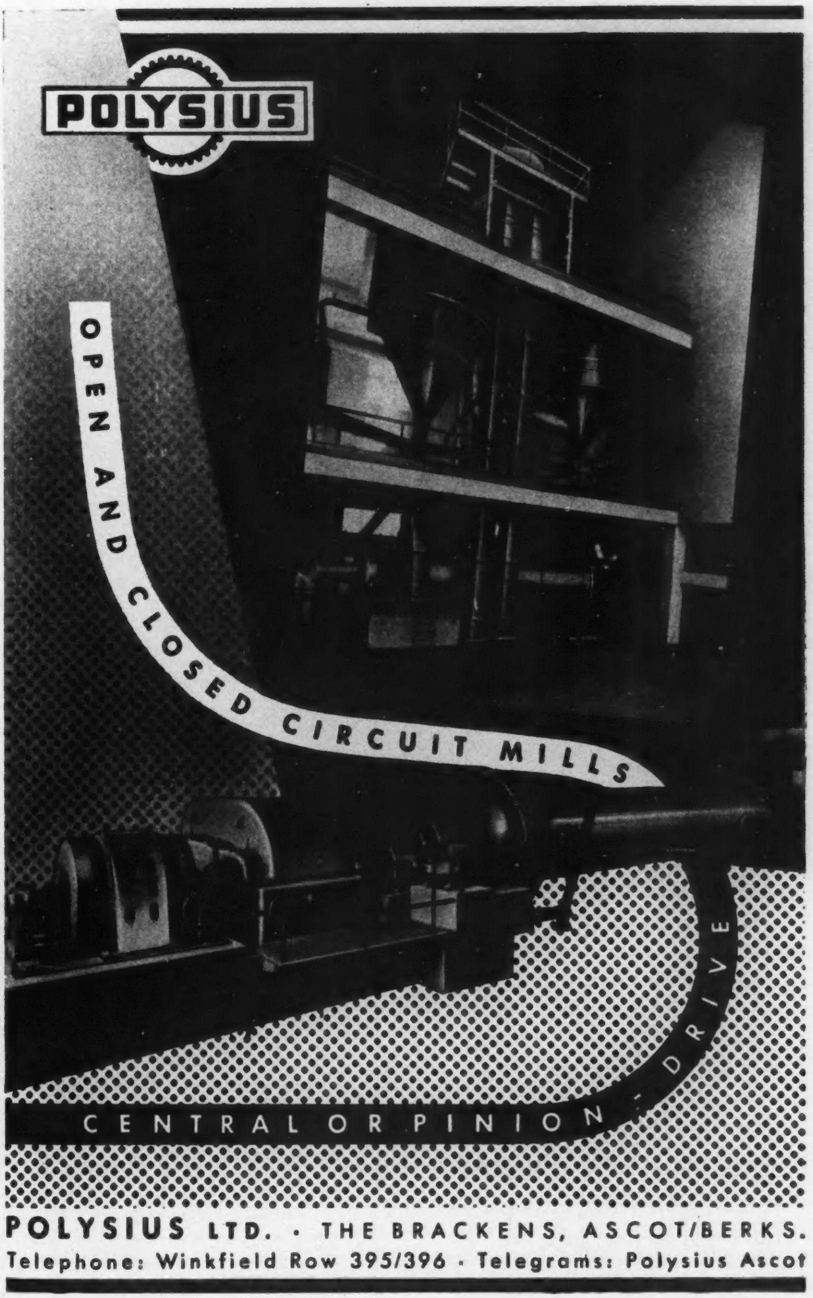
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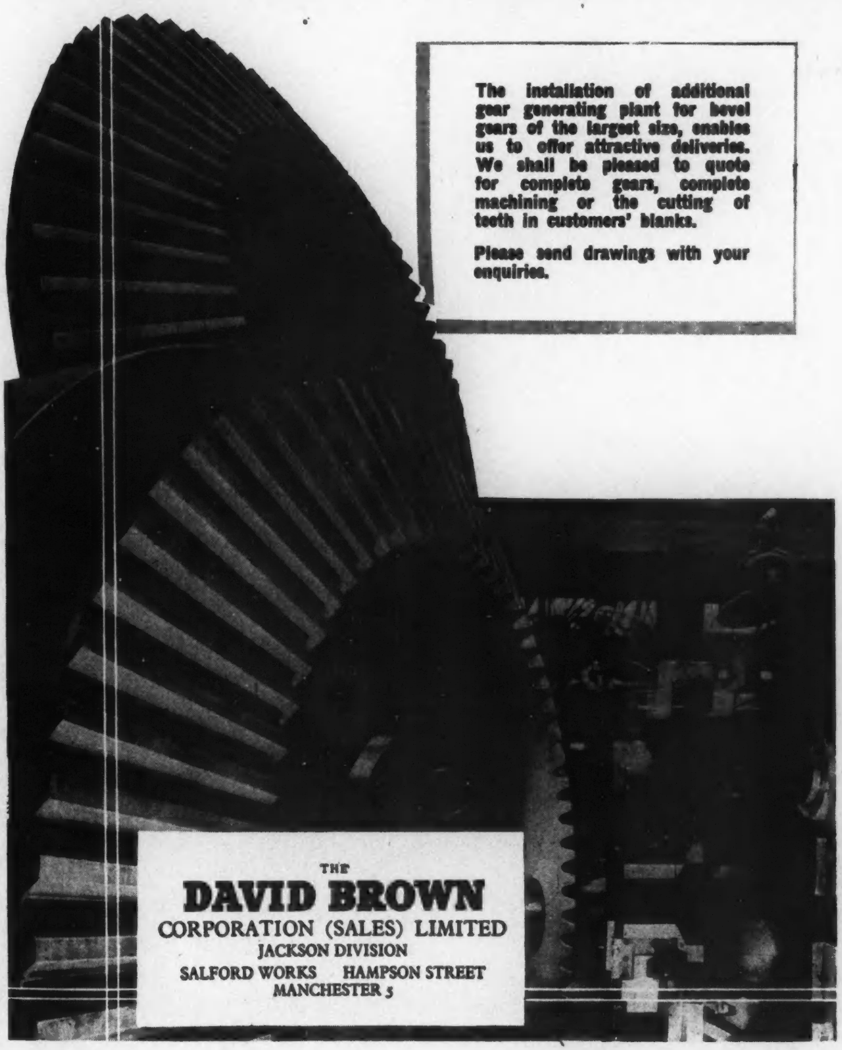

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Pulverised-fuel Ash as a Partial Replacement for Cement in Concrete.

By J. M. WARD, B.Sc., A.R.I.C.

CONSIDERABLE quantities of pulverised-fuel ash are now being used to replace cement in large dams and buildings in the U.S.A. and Canada. The City of New York has recently issued rules under which it will accept 20 per cent. of pulverised-fuel ash as replacement for cement in concrete, and these rules could be applied to most of the pulverised-fuel ash produced at British power stations. The experiments described in this article illustrate how British pulverised-fuel ash may make a successful contribution to economy in building, especially where there is effective control of the mixing of the concrete.

The Pulverised-fuel Ashes Tested.

Pulverised fuel is burned in the combustion chamber of a boiler as a suspension in air, and the ash is therefore fused into small discrete spheres, some of which are hollow. This ash passes through the boiler and is collected at the exit by electrostatic precipitators. Hence the ash has a chemical composition comparable with pozzolanas produced in nature by the action of heat on similar sedimentary silicate materials. However, it has the advantage over pozzolanas found in the earth's crust that it is very finely divided and needs no crushing or pretreatment. A micrograph of typical pulverised-fuel ash is shown in *Fig.* 1. It consists of white and colourless glassy spheres derived from the shale in the coal, and black spheres of magnetite derived from the iron pyrites. There are usually a few cokey particles consisting of incompletely-burned fuel.

The chemical composition of British ashes would not be expected to vary a great deal, since a mixture of coal is burned at most power stations and the ash would tend towards a constant composition representing the average throughout the country. The ignition loss, which is mainly unburned carbon will, however, vary with the type and age of the boiler and the operating conditions. A

survey has shown that, while the chemical composition of ash taken from ten power stations during a year was reasonably constant, the ignition loss varied considerably. The fineness likewise varied, but 73 per cent. of the ashes had specific surfaces between 3000 and 4500 square cm. per gramme measured by the air-permeability method. Ignoring two sources which were consistently high, the ignition loss of 98 per cent. of the samples was below 16 per cent., and of 76 per cent. was below 8 per cent. An attempt was made to obtain samples with ignition losses from 16 per cent. downwards, but the samples received had rather lower ignition losses than was expected, the maximum being 12·2 per cent. The ignition losses, chemical constituents, and physical properties of these samples are given in *Table* I.

TABLE I.—*Chemical Composition and Physical Properties of Fly-Ash Samples*

	Chemical Constituents (%)						Physical properties		
Ash	Silica SiO_2	Alumina Al_2O_3	Iron Oxide Fe_2O_3	Lime CaO	Sulphur trioxide SO_3	Ignition loss (carbon content)	Relative density (g./cm.^{3})	Specific surface (cm.^{2}/g.)	Terminal velocity grading (vel. units)
A	45·0	24·3	7·4	6·8	1·0	5·0	1·87	3,400	3·9
B	41·5	23·1	10·1	10·3	1·4	3·0	—	—	5·9
C	38·7	23·8	8·7	7·3	0·1	8·3	—	—	5·8
D	41·3	21·4	16·0	5·7	0·2	12·2	1·94	3,320	3·9
E	42·9	25·3	11·4	4·8	2·0	5·8	1·82	2,920	3·2
F	38·5	20·8	9·9	13·8	1·1	7·8	1·99	2,380	5·7
G	39·0	21·2	9·3	9·7	0·8	6·1	1·85	2,000	13·2

The chemical constituents were determined by photometric methods. Ignition loss was determined on samples dried at 110 deg. C. by heating at 800 deg. C. for about two hours. The fineness was measured by the air-permeability method described in British Standard No. 12:1947 and also by the "Veloduct" which grades the particles by terminal velocity. The gradings of each sample were reduced to a single figure which is expressed in "vel," being a convenient short-hand defined as follows: an *n*-vel particle has a terminal velocity of *n* centimetres per second in air at 20 deg. C. and 76 centimetres pressure.

Testing Procedure.

The compressive strength of concrete in which part of the cement had been replaced by fly ash was tested at ages up to one year. Slump and compacting-factor tests were made on some batches of concrete immediately after mixing. The soundness and consistency of cement-fly-ash pastes were also measured.

As far as possible, the tests on cement and concrete were in accordance with the recommendations of British Standards Nos. 12:1947 and 1881:1952. It was

decided to confine the tests to mixtures of the same proportions (except for the proportions of ordinary Portland cement and ash) because it had been found that the effect of the ash is similar for mixtures containing other proportions of cement to aggregates. As the fly-ash is most likely to be used in large volumes of concrete, it was decided to use a water content which gave a slump of between 1 in. and 2 in. which led, after several experiments, to the use of a 1:2:4 mixture by volume and a water-cement ratio of 0·65 by weight. The aggregates were crushed stone with a maximum size of ¾ in. and Thames sand. In all cases where ash was used

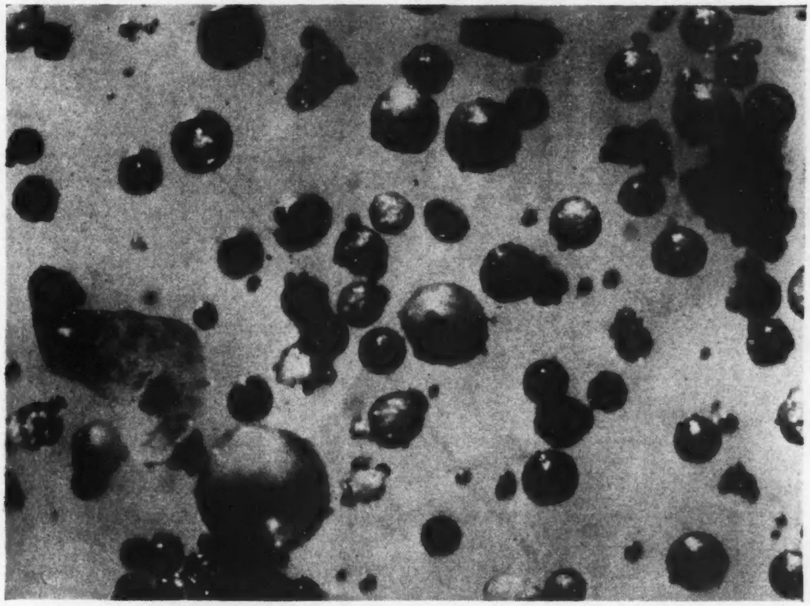

Fig. 1.—Pulverised-fuel Ash (×150).

the cement and fuel-ash were measured by weight and the cement-plus-ash content was considered as cement for purposes of proportioning the mixtures. The initial experiments were made with bags of cement bought in batches as required from a local supplier. Later experiments were made with cement from a 10-cwt. batch thoroughly blended to give a homogeneous composition.

Test Results.

The effects of (1) the ash-cement ratio, (2) the carbon content (ignition loss), and (3) the fineness of the ash, on the compressive strength of the concrete were investigated.

Effect of Ash-Cement Ratio.—*Fig.* 2 shows the variation with age of the strength of concrete in which from 10 per cent. to 40 per cent. of cement was replaced with ash. The ash contained 5 per cent. carbon, and very similar results were obtained with ash containing 12 per cent. carbon.

The 20 per cent. replacement curve shows an apparent increase in strength at early ages, but at three months the strengths were about equal and remained so up to twelve months. The high early strength was probably due to variations in the rate of hardening of the cement from bag to bag. Cements obtained from a large number of sources and with widely different rates of hardening vary only slightly in strength after about a year, so that the results of cubes crushed when one year old are irrespective of the rate of early hardening of the cements used. The slight fall at six months is within the limits of experimental error, and is due in part to slight variations in the curing conditions.

A 10 per cent. replacement appears to increase the early strength of concrete in a similar manner. Tests were made only up to three months, since it was thought that 10 per cent. was too low a replacement to be useful.

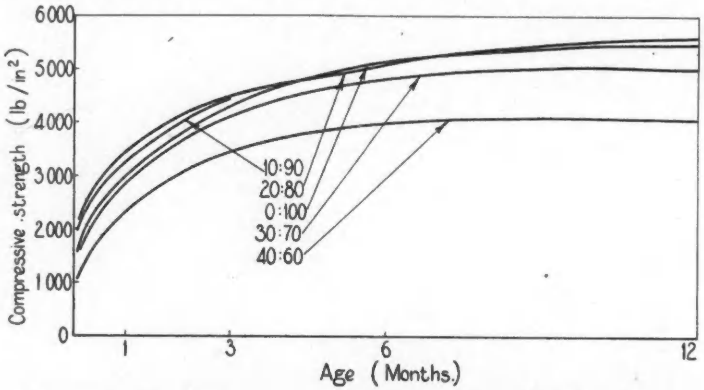

Fig. 2.—Effect on Compressive Strength of Ratio of Ash to Cement.

The concrete in which 30 per cent. of the cement was replaced by ash was a little weaker than ordinary concrete at all ages. A 40 per cent. replacement reduced the strength by about 20 per cent. to 30 per cent. at all ages.

EFFECT OF CARBON CONTENT.—These results showed that a 20 per cent. replacement of cement by the two ashes tested produced a concrete of satisfactory strength and that there was very little difference between fly-ashes with ignition losses of 5 and 12 per cent. It was therefore decided to make concrete cubes using this percentage of other ashes of various carbon contents, but this time using cement from a blended 10-cwt. batch so that the strengths of the ordinary concretes and fly-ash concretes would be comparable at all ages.

The results for three ashes with varying carbon content are shown in *Fig.* 3. It is seen that initially the fly-ash concretes had a lower strength than the ordinary concrete, but the strengths approached one another with increase in time and at about three months were equal. This would be expected, since the pozzolanic action of the fly-ash depends on the lime set free by the hydration of the cement and this increases with time. It seems clear that the relatively high early strengths

in the previous experiments were due to variations in the rate of hardening of the cements. The strengths of all the concretes were close to one another between the ages of three and twelve months, the difference being within the limits of experimental error—the coefficient of variation of results at twelve months was about plus or minus 6 per cent.

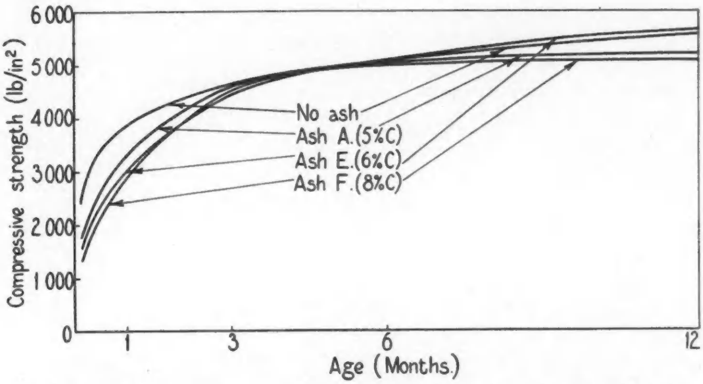

Fig. 3.—Effect on Compressive Strength of Carbon Content of Ash.

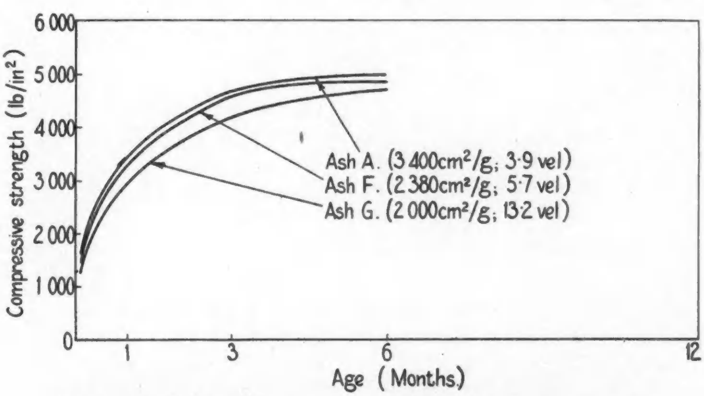

Fig. 4.—Effect on Compressive Strength of Fineness of Ash.

Effect of Fineness.—To see whether the fineness of the ash had a marked effect on the strength of the concrete, the coarsest ash listed in *Table* 1 was selected and in *Fig.* 4 the compressive strengths of concrete made with a 20 per cent. replacement of this ash are compared, up to the age of six months, with cubes in which were used the finest ash and one of intermediate fineness. It is seen that the coarse ash results in a slightly weaker concrete than the finer ones which are within the usual limits of British pulverised-fuel ashes. It should be remembered, however,

that the coarse ash was specially selected and is not typical of most British pulverised-fuel ashes.

SLUMP AND COMPACTING FACTOR.—Tests showed that replacing up to 40 per cent. of cement by ash had no appreciable effect on the slump of the concrete. For all mixtures the slump was between ½ in. and 1½ in.

A comparison between the compacting factor of ordinary concrete and that of mixtures in which 20 per cent. of the cement was replaced with ashes from four power stations showed that there was no appreciable difference in workability. Although the tests showed that the workability was not increased, the impression gained during the handling of the concrete was that the fly-ash mixtures were slightly more workable than the ordinary ones.

If, in concrete construction on a large scale, it is found that concrete containing fly-ash is more workable than ordinary concrete, less gauging water could be used. It has been shown by the Road Research Laboratory that reducing the water-cement ratio from, say, 0.65 to 0.60 increases the strength of fully-compacted concrete made with ordinary Portland cement by about 15 per cent. at early ages. This difference is about the same as that found between concrete containing fly-ash and ordinary concrete at early ages, so that if less water were used fly-ash concrete should have a strength very near to that of ordinary concrete, even in the initial stages, and slightly greater at later ages.

Properties of Concrete containing Pulverised-fuel Ash.

Compared with ordinary Portland cement concrete, concrete containing pulverised-fuel ash has a lower-heat of hydration, so that temperature gradients across large masses of concrete are smaller, and the danger of surface cracking due to differential shrinking during cooling is reduced.

It is also claimed that there is less segregation of aggregate and less "bleeding" with fly-ash concrete, and that it is more resistant to attack by sulphates. This greater resistance would be expected, since sulphates in soil waters react with the hydrated lime and hydrated calcium aluminate in cement, the reactions being accompanied by considerable expansion and the concrete being thereby disrupted; in fly-ash concrete the excess hydrated lime is removed by the pozzolanic reaction with the fly-ash.

Conclusions.

Concrete in which 20 per cent. of the cement was replaced by typical British pulverised-fuel ashes had a strength equal to that of ordinary concrete at the age of three months. At 28 days, strengths varying between 75 and 85 per cent. of the strength of ordinary concrete were obtained.

The results obtained with ashes with carbon contents between 5 per cent. and 12 per cent. were similar and indicate that, within these limits, the carbon content is without appreciable effect on the strength of the concrete.

A 20 per cent replacement of cement with a specially-selected coarse ash results in concrete a little lower in strength, up to the age of six months, than concrete made with the same replacement of ashes with the fineness of most British fly-ashes.

Although, during handling, the impression was gained that the fly-ash con-

cretes were slightly more workable than ordinary concretes, measurements of the compacting factor did not confirm this.

It is suggested that fly-ash concrete could be used in large-scale construction where strict control of quality is exercised. The advantages of fly-ash concrete are lower heat of hydration, a lessened tendency to "bleeding" and segregation, and higher resistance to the action of sulphate-bearing soil waters. The difference in strength between fly-ash concrete and ordinary concrete, at ages up to three months, could be reduced by using less gauging water if fly-ash concrete is found to be more workable in practice. It is possible that the difference in strength could also be reduced by adding more fly-ash than the cement it replaces.

Fly-ash cement could be used in small building works, but since the making of concrete in such work is not always carefully controlled, it might be preferable to blend the ash and the cement at the cement works.

The experimental work described in this article was carried out at the British Electricity Research Laboratories, Leatherhead, and the article is based on Laboratory Report No. 532 by C. L. Neil and J. M. Ward.

Proposed Cement Works in Saudi Arabia.

A proposal to build cement factories at Daman and Taif is being investigated by German interests.

Cement Production in El Salvador.

The output of the cement works at Acajutla, El Salvador, during its first year of production was about 26,000 tons, and it is now proposed to double the capacity of the works. The present output represents about one-third of the cement consumption of El Salvador.

New Cement Works in Cuba.

The cement works at Mariel started production in January, and in the month of February produced 33,300 tons. A new works at Santiago is expected to be in production in August; its capacity is about 1000 tons a day. It is thought that when this works is in production there will be no need to import cement into Cuba.

Proposed New Cement Works in Peru.

Compania de Cemento Portland del Norte is considering the erection of a cement works at Pacasmayo, at a cost of about 3½ million dollars.

Cement Production in Ecuador.

It is expected that a new cement works at Chimborazo will start production this year.

Cement Production in Italy.

Production of cement in Italy in the year 1953 amounted to over 8,000,000 tons.

Prevention of Accidents at Cement Works.

In the year 1950 the Cement Makers' Federation inaugurated an Accident Prevention Advisory Committee for collecting information on methods of preventing accidents and distributing such information to the members of the Federation. The following notes are from the report of the Committee for the year 1953.

During the past four years the number of accidents that caused absence from work for any period beyond the day on which the accident occurred were 551 in 1950, 544 in 1951, 430 in 1952, and 433 in 1953. The frequency rate of such accidents per 100,000 man-hours worked was 2 in 1950, 1·97 in 1951, 1·53 in 1952, and 1·53 in 1953. The average man-hours lost per accident was 204 in 1951, 193 in 1952, and 221 in 1953.

The highest number of accidents in the past three years occurred in the filling and loading departments. Accidents which may be grouped under the general heading of "tripping, slipping, striking, and handling," together with those caused by objects falling, were responsible for about 70 per cent. of the total. The number of accidents caused by machinery was about 6 per cent. of the total. An important factor in preventing foot injuries has been the more general use of steel toe-caps in boots. Injuries to eyes are still a matter for considerable concern; numerous varieties of eye-shields and other protective devices are on the market, but it is difficult to persuade men to use them.

Four fatal accidents were reported during the year. The causes were: (a) A man was buried by a fall of overburden and chalk from the face of a quarry; the cause of the fall could not be ascertained. (b) A man entered a stone hopper to trim stone without assistance and without wearing a safety-belt with rope; he was crushed by a fall of stone and it was presumed that he was carried down with it. (c) An electrician investigating a fault in a switch tried to pull down the handle of the isolator; being unable to do so, he removed the cover of the isolator when an explosion occurred. (d) An apprentice was found dead under a wheel of one of a line of empty chalk wagons. It is presumed that for some reason, probably to take a short cut, he went underneath the trucks and was fatally injured.

Ancillary to competitions held by individual companies in their own works, an accident-prevention competition for the whole of the industry was inaugurated in 1951. The challenge trophy was awarded to the Barnstone works, where there were no accidents during the year 1953.

The Cement Industry in the Belgian Congo.

The firm Ciments du Katanga expects shortly to increase its production of Portland cement to 200,000 tons a year, while Ciments du Congo proposes to install plant with a similar capacity. Ciments de Jadotville recently started production, while the new plant of the Cimental concern at Albertville has started production with an initial output of 40,000 tons per year, which is expected eventually to be doubled. It is also planned to build another plant at Stanleyville. The imports of cement are at present at the rate of about 200,000 tons per year.

Interaction Between Aggregates and Cement.

IN the course of a paper read before the Society of Chemical Industry recently, and fully reported in "Chemistry & Industry" for December 26, 1953, on the deterioration of concrete due to interaction between cement and aggregates, Mr. F. E. Jones, D.Sc. (of the Building Research Station) said that the alkali content of cement did not appear to have been regarded as of much concern in the past, and data were therefore very limited. The following is an abstract of part of the paper.

Fig. 1 gives alkali contents for normal Portland cements received at the Building Research Station since 1928. The data are plotted in the order of receipt, and give percentage Na_2O, percentage K_2O, and the total alkali calculated

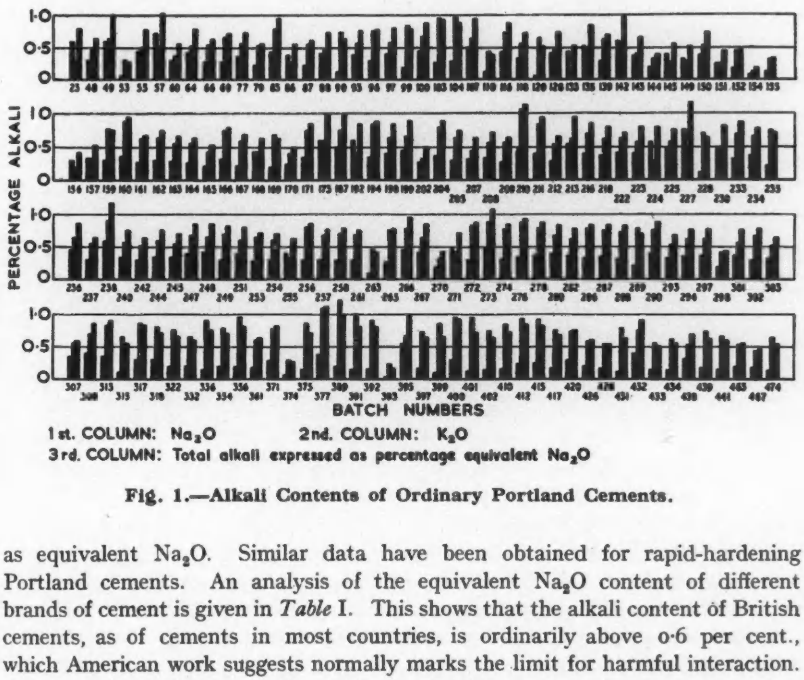

Fig. 1.—Alkali Contents of Ordinary Portland Cements.

as equivalent Na_2O. Similar data have been obtained for rapid-hardening Portland cements. An analysis of the equivalent Na_2O content of different brands of cement is given in *Table* I. This shows that the alkali content of British cements, as of cements in most countries, is ordinarily above 0·6 per cent., which American work suggests normally marks the limit for harmful interaction. It appears therefore that, if reactive material is present in aggregates, some discrimination should be used in the choice of cement and a low alkali content specified.

Reduction in alkali may be valuable not only to reduce any possible alkali-aggregate reaction but to improve the quality of concrete, and to reduce surface crazing. Also, alkali content may be significant with respect to materials embedded in or in contact with cement and concrete. While alkali solutions are protective

TABLE I.—EQUIVALENT Na_2O CONTENTS OF BRITISH PORTLAND CEMENTS.

Brand of cement	Number analysed	Number of cements with equivalent Na_2O content stated							
		<0·4	0·4—0·5	0·5—0·6	0·6—0·7	0·7—0·8	0·8—0·9	0·9—1·0	≥1·0
Ordinary Portland cements									
A	84	—	3	5	12	29	22	11	2
B	35	—	1	4	9	8	8	3	2
C	16	3	5	5	2	—	1	—	—
D	8	—	—	—	2	3	2	—	—
Other brands	34	2	1	4	5	13	1	4	4
Rapid hardening Portland cements									
E	41	3	—	6	8	11	8	5	—
F	34	2	3	3	11	5	6	4	—
G	6	—	—	1	—	1	2	2	—
H	4	—	—	1	—	1	—	2	—
Other brands	20	—	2	3	2	3	8	2	—

to iron and steel, they are corrosive to metals such as lead, zinc, and aluminium. Although direct evidence is lacking or inconclusive, it seems likely that in the alkali concentrations to be expected in cements there may be significant differences in rates of attack. It seems possible too that reduction in alkali content may lead to decreased action on oil paints.

Among the points to be considered are (1) The amount of alkali released on hydration of cement. (2) The total alkali content may be significant only insofar as all the alkali can be released into solution. (3) The relative rates of release of both sodium and potassium may be significant. (4) The effect of sodium hydroxide may not be the same as that of potassium hydroxide for equal molecular contents.

To get information on the total alkali that may be released into solution and the relative rates of release of sodium and potassium, extraction tests involving shaking cement with water were made on five ordinary and three rapid-nardening Portland cements. The results show that extraction of both sodium and potassium proceeds at first rapidly, then at a diminishing rate, and is practically complete in 28 days. It appears therefore that all the original alkali content of cements must be effective in alkali aggregate reactivity provided that complete hydration occurs. The rate of release of alkalis appears to be much the same for different cements. No significant differences were observed in the rates for sodium and potassium, though Gilliland and Bartley suggested that sodium dissolved faster. Apart from this the main results are in substantial agreement.

British Aggregates.

SEDIMENTARY ROCKS.—Because of the extensive use of flint gravels as concrete aggregate, and the statements in geological publications that flint contains "opal" or "soluble silica," it is necessary to consider flint and chert carefully. It seems possible that even a slow reaction, which might otherwise be harmless, might, under severe exposure, materially reduce the life of concrete. A second case for special consideration is that of aggregates that have their source in or may be mixed with material derived from the Upper Greensand of the Cretaceous system. This arises with malmstones and firestones containing opal.

FLINT AND CHERT.—Authorities disagree on the precise constitution, but usually the statement is made that opal is present. Work by Midgley indicates,

however, that both flint and chalcedony, which is often stated to occur in flint and chert, are to be regarded as microcrystalline and microporous varieties of quartz, opal not being present. Midgley suggests that flint and chalcedony may be classified on the basis of refractive index and water content, chalcedony having a water content of less than one per cent.

Reactivity of flint and chalcedony has been indicated by various authors in America, at any rate at slightly raised temperatures. However, in America it appears that expansion is generally only significant when flint is mixed in certain proportions with inert material. With greater or lesser contents of reactive material, expansions are considerably reduced. It may thus be that flint gravels and sands, used as a whole, are normally harmless so far as expansion is concerned.

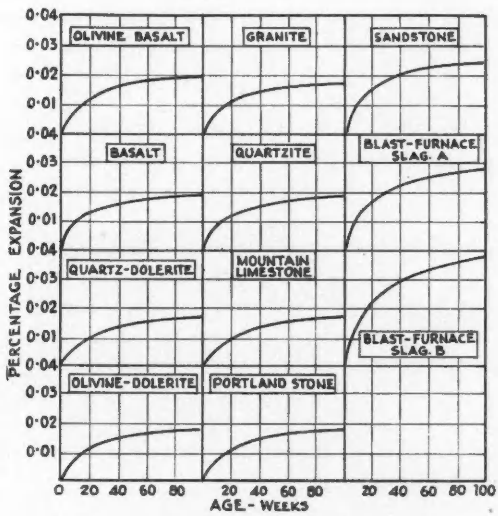

Fig. 2.—Expansion of British Aggregates.

However, they should strictly be considered as slightly reactive, and it appears that if they are with inert aggregates there is a possibility of sufficient expansion occurring to cause trouble in some degree. Temperature may be significant.

IGNEOUS ROCKS.—Of igneous rocks only the acid and intermediate volcanic rocks are likely to be reactive. Trachytes have not been associated with reactivity. Andesites are stated by Holmes to be quarried less than basalts and dolerites, partly because the latter are preferred, and partly because of the remoteness of the rock. Dacites have been referred to in American work as reactive.

Of the basic volcanic rocks, dolerite, and basalt are the chief types included in the term " whinstone." These rocks are not reactive with alkalis, at any rate when not decomposed.

Tests.

At the Building Research Station two main series of specimens were prepared, one of high-quality bars of low water-cement ratio and relatively low porosity, the other of lower-quality bars of high water-cement ratio and relatively high porosity. Results are available up to four years. The tests with relatively high water-cement ratio and porosity have confirmed the reactivity of two American aggregates included for comparison, and also show that none of the normal British aggregates so far tested is expansively reactive when used as a whole aggregate. The results in general confirm the behaviour found with similar aggregates in America and elsewhere.

The cement used in these tests contained 0·18 per cent. Na_2O and 0·77 per cent. K_2O, the total alkali being equivalent to 0·7 per cent. Na_2O. The aggregates included crushed basalts and dolerites, granite, quartzite, sandstone, mountain limestone, Portland stone, blastfurnace slags, flint sand, a ferruginous sand, quartz sand, malmstone, and two reactive aggregates from America, including a sand from Kimball (Nebraska) and a siliceous magnesium limestone from California. Bars of high-quality concrete using water-cement ratios generally of about 0·28 with careful compaction showed no significant expansion, even with the reactive American aggregate. The use of such mortar or concrete would, however, be quite impracticable in practice.

The Cement Industry in Turkey.

The total capacity of the cement industry in Turkey in 1950 was 395,000 tons. During the past three years production has been increased to 1,025,000 tons. It has now been decided to expand the Ankara cement factory and (as reported in our May number) to construct twenty new factories at a total cost of £T220,000,000; when these works are completed the total capacity of the industry will be 3,000,000 tons a year.

New Cement Works for Angola.

A new cement works is to be built in Angola, Portuguese West Africa, by Campanhia Geral de Cal e Cimento, of Lisbon.

Cement Production in Spain.

The production of Portland cement in Spain in the year 1953 was 2,540,000 tons, an increase of 11·6 per cent on the previous year.

Sales of Cement in Switzerland.

At 1,500,000 tons, sales of cement in Switzerland in 1953 were 14 per cent greater than in 1952.

New Cement Works in Pakistan.

A new cement factory, with a capacity of 500 tons a day, is to be built at Manghopir, near Karachi, by the Pakistan Industrial Development Corporation. This works, which is to be completed by the end of the year 1956, will be the third cement works built by the Corporation.

The British Cement Industry in 1953.

The following is abstracted from the address of the Chairman, Sir George Earle, C.B.E., at the annual general meeting of the Associated Portland Cement Manufacturers, Ltd., held in London on July 8.

Last year the demand for cement was heavily swollen by defence needs and was greater than production. Exports were well maintained. As they were responsible for about two-thirds of the cement production in this country, they had a special duty to keep the home market supplied and to do their full share of the export trade. The only way in which this could be done in 1953 was by importing cement from the Continent. The imported cement was sold at the home trade price and realised over £800,000 less than its cost; this was the main reason for the reduction in the trading surplus.

There was a substantial reduction in the dividend from the companies in Mexico due to reduction in demand and heavy increases in the cost of fuel, railway freights, and wages. Selling prices were not increased. The Mexican peso was devalued in April, 1954, by about 44 per cent., and this would reduce the Sterling value of dividends received by about one-third.

Associated International Cement, Ltd., which owns part of their overseas investments, paid interest in 1953 on the loan account, and had declared a maiden dividend. The Australian Company made a profit on the year and its prospects had improved appreciably.

Production.—The clinker production of the group was only 95,000 tons more than in 1952, because four of the largest works were temporarily closed owing to the floods and more than 50,000 tons of output were lost. Production this year was 215,000 tons higher than for the same period of 1953. Comparing the years 1953 and 1939, the home trade increased from 5,100,000 tons to over 6,000,000 tons, and exports increased from just under 600,000 tons to just over 1,200,000 tons. The overseas Companies increased their deliveries from 552,000 tons to 1,505,000 tons.

Two new works were to be built in England, at Westbury in Wiltshire and Cauldon in Staffordshire. The markets which these works would supply were at present supplied from existing works at a high cost in transport. The cost of building them was fantastic—over four times the pre-war cost—which meant that depreciation charges would be very high and that, although output per man would be higher than at existing works and the fuel consumption lower, these savings would not nearly make up for the additional depreciation charges. The new works would make possible large savings in transport in supplying local markets, and in turn enable cement to make shorter journeys in other districts. Without these savings in transport it would not be economical to build the new works.

Clinker from Sulphuric Acid Plant.—The grinding and packing plant at Widnes, which would receive clinker from the sulphuric-acid plant of the United Sulphuric Acid Corporation, was finished, but it would be next year before the clinker was available. They had also agreed to purchase all the cement which would be produced from the sulphuric acid plant at Whitehaven, and to give the

makers any technical advice they might require on cement. The quality of the cement to be produced at Widnes and Whitehaven should be very satisfactory. These four new sources of supply would produce rather more than half-a-million tons a year.

LOOSE CEMENT.—A development in distribution was a new bulk handling plant to supply the London market, which would be in use this year. It was the first plant of its kind in England. Loose cement would be delivered to the wharf in barges, mechanically unloaded into silos at the rate of 150 tons an hour, and loaded into lorries in bags or loose at over 100 tons an hour. Provision was being made to increase this rate to 200 tons an hour.

CEMENT WORKS OVERSEA.—The raw materials near Salisbury in Southern Rhodesia had been proved to be suitable, and it was hoped to start building the works this year. The Company would be a Southern Rhodesian company, and the group would provide the ordinary capital except for that part which would be offered for public subscription in Southern Rhodesia. The planned production was 120,000 tons per annum, and the works was being designed so that it could be expanded without difficulty. In Kenya progress was slow, but the raw materials were also suitable, and it was hoped that the East African Portland Cement Company, in which they and the Tunnel Company had substantial holdings, would start building a works there shortly; the works was designed for a capacity of 100,000 tons a year. In Mexico, the third large kiln at Tolteca should be in use this summer, and this works should then be comparable with the Shoreham works in this country. In Australia an old kiln was being modernised, and should be operating this year. In Malaya the works was operating smoothly, and in March and April delivered over 15,000 tons of cement. The bulk carrying ship for New Zealand should sail in July, and satisfactory progress was being made for the handling of cement in that country.

In South Africa good progress was being made with the new kiln and ancillary plant, and it was expected to be operating in 1955. They were investigating possibilities of expansion in other parts of the Commonwealth, but these investigations were in their early stages.

OUTPUT PER MAN-HOUR.——Further progress had been made in production per man hour. It was 1.5 per cent. higher than in 1952, and 25.6 per cent. higher than pre-war. The comparative figure for the men's earnings was about 200 per cent. above 1938 for the same number of hours worked.

DUST PREVENTION.—The question of dust emission from the factories had received close attention during the year; since the war they had spent £789,967 on dust prevention plant at their works.

ACCIDENT PREVENTION.—For over 30 years they spent much time and thought on the prevention of accidents, and though they were far from satisfied with the present figures, they had had some success. The lost-time accidents per 100,000 man-hours worked last year were 1.42 compared with 3.61 in 1934 and 2.54 in 1938. The Barnstone works just completed three years without a lost-time accident.

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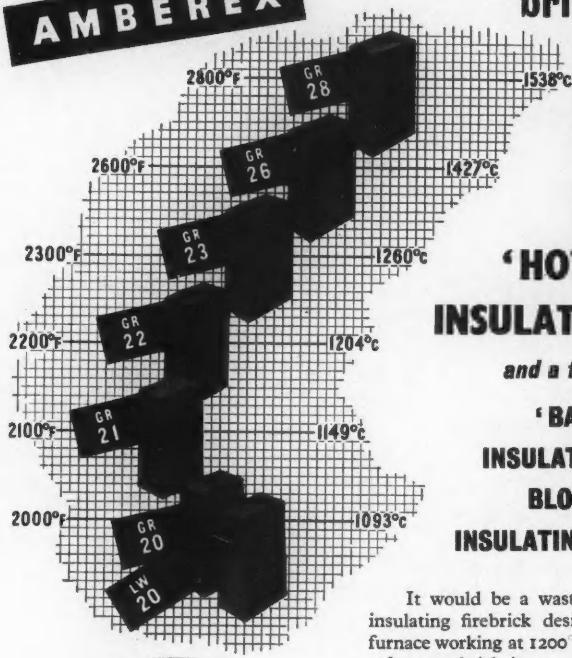

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